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Effect of Problem Based Learning Toward Mathematical Communication Ability and Self-Regulated Learning

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Abstract
This study was essentially set out in order to determine the significant effect of problem-based learning and conventional model to students' mathematics communication skills and their independent study in which the students' responses were included for each lesson. The study design was a factorial design. The population involved was the entire students of class VIII SMPN 1 Dewantara, North Aceh. Sample using random sampling instrument used in the study consisted of testing the ability of early mathematics, mathematical communication skills, as well as independent learning questionnaire. The data was analyzed by using ANACOVA. The results showed that: (1) a significant difference model (PBL, Conventional) on the ability of mathematical communication, the average difference communication abilities of female students is higher than male students is 16.202 compared to male students 14.769, (2) There is a significant effect model (PBL, Conventional) on the ability of independent learning. (3) The process of settlement of the students' answer to Problem Based Learning is better than conventional learning.
Keywords: Mathematics Communication Skills, Self-Regulated Learning, Problem based learning, Conventional Learning.

1. Introduction

The tendency of mathematics learning based on authentic problems which can effectively enhance students' communication skills and self-regulated learning has been implemented in many countries (Sungur & Tekkaya, 2006; Portela, 2007; Cheong, 2008; Stahl et al., 2010; Qohar & Sumarmo, 2013; English & Kitsantas, 2013; Sufi, 2016).

Mathematics communication skills are the students' capabilities to speak, to write, to explain mathematical ideas and to create interactions and explorations of their ideas in classroom through group discussion and also their ability to communicate mathematics as a message that needs to be delivered (NCTM, 2004). Mathematics communication skills in classroom implementation needs to be taken care of, this is because of mathematical communication are able to organize and accommodate students' mathematical thinking (Saragih, 2007). It can bridge the students to a deeper mathematics concept understanding when they already have this capability (Stahl et al., 2010; Ramelan et al., 2012; Siregar, 2016).

However, the students' mathematics communication skills and self-regulated study, in fact, is still below the average. This is research from the observations made in the initial SMP 1 Dewantara district, North Aceh, indicating that students are not able to start solving problems by creating mathematical models of the information provided, they just write down the answer without writing how the settlement process to get the answer. So what happens is not be resolved or the result of an answer from the given problem cannot be solved exactly. So also with the independence of the students obtained the information students experiencing self-regulated learning is still low, especially in working on assignments and homework assigned by teachers. Most students at that school are likely to learn depends on the teacher, the students are waiting to be ruled by the teacher in the learning especially in the task or homework, then students tend to imitate his work to be lazy and not sure of his ability

Communication skills and independence of learning students are still low in the course of some factor which becomes the cause, one that is still learning the teacher-centered, where teachers have not selected for this model, the right strategy in delivering material to be taught. On the implementation, during the teacher more often apply to conventional learning or better known as direct learning. That explanation is reinforced by the results of survey research Santoso (2015:220), who mentions in a few schools found that many teachers of mathematics real school level, either elementary, junior high schools, and high schools that still use direct learning or teacher-centered learning. Surya and Rahayu (2014) found that one of the causes of poor communication skills and mathematical problem solving of students is less exact orientation learning math in school (Nasution, dkk, 2013; Oktaviarini, 2015).

Given the importance of mathematical communication ability and self-regulated learning of students, then needed an innovative effort to overcome. Where students need to be conditioned to being able to reconstruct his knowledge as well as capable of transforming his knowledge in other situations are more complex so that the knowledge would be have students itself. The process of contructionly the knowledge can be done by students

based on the experience that has been, and can also be the result of the invention involving the environment as a factor in the process of acquiring knowledge. One of the ways that can be grown with seek learning using approaches, models or strategies according to the flow of construction which can provide opportunities and encourage students to practice mathematical communication ability and independence of learning students. One of the learning models are the most appropriate and best suited to fostering mathematical communication ability and self-regulated learning is a model project based learning.

2. Theoretical Framework

2.1. Problem Based Learning

Problem-based learning (PBL) is probably the most innovative learning methods are never implemented in school education, the effectiveness in facilitating student on problem solving skills and independent study has been reported widely in medical education (Barrows and Tamblyn, 1980; Schmidt, 1983). LBC make it also popular across the disciplines in higher education and the implementation of school-level education (Barrows, 2000; Dochy et al., 2003; Gallagher et al., 1992; Hmelo-Silver, 2004; Hmelo et al., 2000; Torp dan Sage, 2002; Williams dan Hmelo, 1998; Fatade, et al, 2013)

PBL is a learning model that is designed to boost the morale of students active and get involved in their learning and experience can also hone, test and develop his thinking ability on an ongoing basis. Solanki & Sumarmo (2007:118) explains that the problem-based learning as a learning approach that begins with the presentation of the problem which is designed in a context relevant to the material to be learned to push students: gain knowledge and understanding of concepts, critical thinking, having reached independence of learning, participate in group work skills, and problem solving ability.

It is also spoken by Ibrahim and Nur (Trianto, 2011:96) that the problem based learning is not designed to help teachers provide much information to students, but to help students develop thinking ability, problem solving, intellectual skills, learning the role of adults as well as being autonomous and independent learning. Through PBL applied are expected of students in the learning process in the classroom, can foster mathematical communication skills and be able to shape the personality of the students become self-regulated learning in the range of problems faced by students. PBL also tried to help students to become independent learners and *self-regulated*, guided by teachers who always give spirit and reward when they ask questions and find their own solutions to real problems, would students learn to carry out its work independently.

2.2. Mathematics communication ability

Mathematics communication ability is the ability of students to express ideas, ideas in mathematics, whether oral, in writing or in the form of language, symbols, and mathematical notation-notation mathematics in order to make it easier for students to understand problems in mathematics. Communication skills measured indicators, namely: 1) expressing mathematical ideas or situations of an image or graphic provided with the words themselves in the form of writing (writing); 2) States a situation in the form of a picture or graphic (Drawing); 3) is able to declare the situation in the form of notation-notation mathematics or mathematical models (mathematical expressions). (Baroody, 1993; NCTM, 2000; Pugalee, 2001; Wijaya, et al., 1999)

Mathematical communication reflects an understanding of mathematics and is a part of the power of mathematics. Students learn mathematics as they talk and write about what they're working on. Greenes and Schulman (Ansari, 2012:4) stated that mathematical communication is: (1) the central force for students in formulating mathematical concepts and strategies, (2) capital of success for students of and settlement in the exploration and investigation of the mathematical, (3) container for students to communicate with his friend to obtain information, share thoughts and discoveries, brainstorming, assess and sharpen ideas to convince others.

Through communication students can explore and consolidate its mathematical thinking, knowledge and development in solving problems with the use of mathematical language can be developed, so that mathematical communication could be established. Communication skills are very intensively so that there need to be students actively involved in learning and remove the impression that mathematics is a lesson that is unfamiliar and frightening. Mathematical communication skills also are important because the math is basically the language requirement with the notation and terms to concepts that are formed and understood and manipulated by students (Stahl, et al., 2010)

2.3. Self-Regulated learning

Zumbrunn, et al (2011:4) stated that the independence of learning is a process that helps students manage their thoughts, behavior, and emotion in order to successfully cope with their learning experience. Self-regulated learning is a person's ability to manage own learning experience effectively in various ways so as to achieve optimal learning outcomes. Self-regulated learning indicators are: 1) the evaluation of the progress of the task (evaluating self-esteem); 2) Arrange the subject matter (organization and information); 3) make plans and learning objectives (goal setting and planning); 4) looking for information (information seeking); 5) set up a

learning environment (enviromental structuring); 6) Repeating and remembering (revision and memory); 7) enlisted the help of friends, teachers, adult (seek per, teacher, adult assistence); and 8) Repeat the previous tests/assignments *(review test/work).* (Zimmerman and Schunk, 1989; Darr and Fisher, 2004, Pape, 2003).
Self-regulated learning is a skill learned in the individual learning process driven, controlled, and assessed by the individual themselves (Lilik, dkk, 2013:64).Self-regulatedlearning needed by students so that students have a responsibility to regulate and discipline themselves. The need for the development of self study on self-regulated learning studying math is also supported by some of the findings include findings Fauzi (2011:111) the importance of self-regulated learning math curriculum so that students ' demands because it could face problems in the classroom and outside the classroom that increasingly complex and reduce the reliance of students with others in everyday life. The students are said to have been able to learn independently if has been able to undertake the task of learning without dependence with others. Because of this independence is basically individual behavior that are able to take the initiative, capable of overcoming obstacles/problems, have confidence and can do something yourself without the help of others.

3. Research Methodology

3.1. Method

This type of research is *quasi experiment* conducted on grade VIII SMP 1 Dewantara North Aceh Regency Years lessons 2015/2016. Design using design of *factorial design.*

Table 1. Design Research

Group Treatment	Treatment	*Gender*	*Postest*
(Experimental)	X	Y_1 / Y_2	O
(control)	-	Y_1 / Y_2	O

(Source: Sugiyono, 2010:76)

Description:
X : *Problem Based Learning*
Y_1 : Gender male
Y_2 : Gender Female
● :Postest

3.2. Population and Sample

The population of this research is the whole grade VIII in SMP 1 Dewantara which consists of 8 classes. With the technique of *random sampling,* the sample was selected the class $VIII_1$as many as 46 students as class experiments are learning PBL, as well as the class $VIII_3$ as many as 46 people are students who are learning.

3.3. Research Data

Data required in this research is the KAM (the ability of early mathematics), mathematical communication, postest score and the now standalone learning. Further data are descriptive and inferential were analyzed using the ANACOVA test. The use of ANACOVA caused in this study using variable companion (KAM) as free variables that are difficult to be controlled but can be measured simultaneously with variable bound to a result of learning (mathematical communication ability and self-regulated learning).

3.4. Test Instrument

Mathematical communication skills Test Instruments is done in the form of granting reserved as much as 5 reserved structured description with 3 mathematical communication indicators, namely: 1) expressing mathematical ideas or situations of an image or graphic provided with the words themselves in the form of writing (write); 2) declaring a situation with a picture or graphic (drawing); 3) States the situation into the mathematical model (mathematical expressions). For learning independence given the now.

3.5. Data Analysis

Data analysis in this study consisted of testing normality, testing its homogeneity, average difference testing, calculation of the index gain, and hypothesis testing. Statistical hypothesis testing in this study using ANACOVA.All hypothesis testing is done at the level of significance 0.05 and by using SPSS program 21.0 help *for windows.*

4. Results

Early mathematics Ability test results obtained from tests conducted when the grant will do research by giving students multiple choice question 15. To obtain an overview of the average calculation is done student KAM and deviation standard. Summary of results is presented in table 2 below.

Table 2. The Description of The Early Mathematical Ability Test Results Students Each Class Samples

Descriptive Statistics							
	N	Minimum	Maximum	Sum	Mean		Deviation Std.
	Statistics	Statistics	Statistics	Statistics	Statistics	Std Error.	Statistics
KAM_1	22	53	87	1505	68.41	2.435	11.421
KAM_2	24	40	80	1353	56.38	2.262	11.080

Based in table 2 visible that the average score for each different class. To know the equivalence class of experiments and KAM score class control to do test data normality tests include analysis and its homogeneity test (test average difference).

The hypotesis was tested to find out data normality KAM is:

H_o : The sample comes from a Gaussian population

H_a : The sample comes froma population that is not Gaussian

The testing criteria, if the value of significance (sig) is greater than $\alpha = 0{,}05$, then the H_o is accepted; in terms of other $H_a$is rejected. These are used to test the hypothesis test kolmogrov-Smirnov (K-S-Z). Summary of results is presented in table 3.

Table 3. Test Result Value of Normality Early Mathematical Ability of Students

Tests of Normality							
	LEARNING	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
		Statistics	DF	Sig..	Statistics	DF	Sig.
KAM	PBL	, 156	22	, 175	, 911	22	,050
	Conventional	, 170	24	, 071	, 938	24	, 147

a. Lilliefors Significance Correction

Based on the test results table 3 *Kolmogrov-Smirnov Z* seen that value the significance of experimental class of 0.05 > classroom and 0.175 control of 0.071 > 0.05, then it can be concluded early mathematical ability of students in two classes of distribution normal, in other words the zero-hypothesis is accepted.

The results of the calculation of its homogeneity KAM from both groups in the following table 4.

Table 4. Test Results of Homogeneity KAM of Students' Test of Homogeneity of Variances

KAM			
Levene Statistics	df1	df2	Sig.
, 181	1	44	, 672

Based on the results of test *Levene* using *SPSS version 9*, it is noted that the value of*significance (sig)* Thurs of 0.672. This means that the value of *Significance* (*sig)* the le of bih = 0.05 ability test result data so that the beginning of mathematical experiment class students and classes of homogeneous control. Based on its homogeneity and normality testing that has been done above, then it can be inferred that the mathematical ability of students ' data initial Gaussian and homogeneous.

Next to the student's mathematical communication ability (SMCA) quantitatively can be seen in table 5 andtable 6.

Table 5.The Mathematics Communication Ability Students in PBL ClassinQuantitative

No.	Interval Value	The Total Number ofStudents	Percentage	Assessment Category
1	$0 \leq$ SMCA < 45	0	0%	Very Less
2	$45 \leq$ SMCA < 65	0	0%	Less
3	$65 \leq$ SMCA < 75	6	27.2%	Enough
4	$75 \leq$ SMCA < 90	16	72.8%	Good
5	$90 \leq$ SMCA ≤ 100	0	0%	Very Good

Table 6.The Mathematics Communication Ability of Students In Conventional Class

No.	Interval Value	The Total Number of Students	Percentage	Assessment Category
1	0 ≤SMCA< 45	4	16.7%	Very Less
2	45 ≤SMCA< 65	13	54.1%	Less
3	65 ≤SMCA< 75	7	29.2%	Enough
4	75 ≤SMCA< 90	0	0%	Good
5	90 ≤SMCA≤ 100	0	0%	Very Good

From table 5 and table 6,the mathematics communication ability with the mathematics students in class learningproblem-based learningis obtained that, the number of students who obtained a value of the category quite as many as6 people or of27.2%, that hasa value categories either as many as16people or72.8%, While for the communication mathematics ability students on classroom learningconventional obtained that, the number of students who gain value very less as much as people or amounted to16.7%, which has a categories as many as13people or exactlys 54.1%, which has a value of the category quite as much asof 7 person or of 29.2%,

Mathematical communication skills Test was followed by 46 students consisting of classroom experiments and classroom control. Mathematical communication ability tests carried out in the form of granting reserved as much as 5 reserved structured description with 3 mathematical communication indicators, namely: 1) expressing mathematical ideas or situations of an image or graphic provided with the words themselves in the form of writing (write); 2) declaring a situation with a picture or graphic (Drawing); 3) States the situation into the mathematical model (Mathematical Expressions).

Based on the analysis of the data, obtained an average score of mathematical communication ability of students for classes learning PBL i.e. amounting to 75.14 and to conventional learning classes registration 55.04. The data shows the average value of mathematical communication skills students are provided learning PBL is higher than that givento conventional learning.Then fromthe average looks that mathematical communication skills of students using PBL learning, namely: male (71.034) and women (74.367) greater when compared with students who use conventional learning are: male (56.265) and women (58,165). Furthermore, the difference between the average mathematical communication skills among students who were given conventional learning and PBL learning in a row for male students of 14.769 and women of 16.202.

This suggests that PBL learning has great effect in developing the mathematical communication skills. Learning PBL has managed to improve the mathematical communication skills students when compared to conventional learning.

Furthermore, for his work on student learning independence results tallied the lowest score, highest score, average score and standard deviation per experimental and control and class, as summarized in table 7 below:

Table 7. Recapitulation of Score Self-Regulated Learning

Descriptive Statistics

Class	N	Minimum	Maximum	Mean	Std. Deviation
Experiment	22	68	94	83.64	7.531
Control	24	67	84	77.08	5.579

In table 7, it can be seen that self-regulated learning on classroom experiments given learning problem based learning obtained an average 83.64 with a standard deviation of 7.531, minimum value and maximum value 68 and 94. Whereas the independence of the control class to study who were given conventional learning obtained an average 77.08 with a standard deviation of 5.579, the minimum value and the maximum value 67 and 84. To self-regulated learning students' (SSRL) in quantitatively can be seen in Table 8 and Table 9.

Table 8. Self-Regulated Learningof the PBL Class In Quantitative

No.	Interval Value	The Total Number of Students	Percentage	Assessment Category
1	0 ≤SSRL < 45	0	0%	Very Less
2	45 ≤SSRL < 65	0	0%	Less
3	65 ≤SSRL < 75	3	13.64%	Enough
4	75 ≤SSRL < 90	16	72.72%	Good
5	90 ≤SSRL ≤ 100	3	13.64%	Very Good

Table 9. Self-Regulated Learning of the Conventional Class in Quantitative

No.	Interval Value	The Total Number of Students	Percentage	Assessment Category
1	0 ≤ SSRL < 45	0	0%	Very Less
2	45 ≤ SSRL < 65	0	0%	Less
3	65 ≤ SSRL < 75	7	29.17%	Enough
4	75 ≤ SSRL < 90	17	70.83	Good
5	90 ≤ SSRL ≤ 100	0	0%	Very Good

From tables 8 and 9 self-regulated learning in class PBL is obtained that, the number of students who gain valueveryless as much as 0 or 0% of people, who have less categories as many as 12 people or of 0%, which has a value of the category quite as many as 10 people or as big as 13.64%, which has a value of either category as many as 16 people or 72,72%, that has the value categoryverygood 3 people or as much as 13.64%. While for the self-regulated learning in the classroom learning the conventional obtained that, the number of students who scored very less as much as 0 or 0% of people, who have less categories as many as 12 people or of 0%, which has a value of the category quite as much as of 7 person or of 29,17%, which has a value of either category of as many as 17 people or 70,83%, which has a value of the category of very good 0 people or as much as 0%.

5. Discussion

Based on the result, it is found that the overall indicator for all mathematics communication ability with mathematical PBL better thanconventional learning. This is in line with the findings of the Fachrurazi (2011:76) who suggested that the mathematics communication ability of students who are taught by learning PBL higher compared to students taught with the conventional learning. This is because learning PBL indeed facilitate the student's communication skills, especially in providing the means to train the ability of problem-solving. When students are given a problem, then this aspect of mathematical communication ability developed i.e. aspects of reading because before think students should first read and understand the given problem. After students understand and reading problems, then it is in the minds of students would show up a range of ideas to solve the problem. According to Piaget's theory (Trianto, 2011:29) looks at cognitive development as a process which is actively building a system of meaning and understanding of reality through the experiences and interactions – their interactions. Piaget (Arends, 2008b: 46) declaring children have an innate curiosity and continuously trying to make sense of the world around it. Their curiosity, will motivate them actively to build/construction with representation-representation them about the environment they face. Correspondingly increasing age, the child will be more and more get the capacity of language and memory. Next Pannen (Fatimah, 2012:275) disclose in accordance with the theory of learning in a PBL models where it is composed of two core stages, namely the analysis of problem solving in collaborative and independent study. So it can be inferred, there is significant effect model (PBL, conventional) of mathematical communication ability.

Based on the analysis of the data, obtained an average score of self regulated learning the gain of 83.64 and PBL to conventional learning classes registration 76.88.The Data shows the average value of the independence student learninggiven the higher of PBL in given conventional learning.Then fromthe average looks that self-regulated learning of the student using PBL:female (80.71) and women (82.32) larger if compared with students who use conventional learning are:female (77.22) and women (80,11).Furthermore, the difference in average learning self-reliance among students who were given conventional learning and PBL learning in a row for male students of6.56and women of2.21.This shows that learning PBL has influence in developing self-regulated learning. PBL has managed to increase the self-regulated learning if compared with the conventional learning.

Problem-Based Learning can give you a great effect towards mathematics communication ability and self-regulated learning compared to conventional learning. This is confirmed by the results of the findings of Marzuki (2012:223) suggests that mathematical communication skills of students who were given the learning model of PBL better than students who are given direct learning. Suhery (2013:124) States that there is a difference the increased independence of the learning of students who are taught using model PBL between of students who are taught with the conventional learning model. Many of the factors that caused the communication ability and self-regulated learning that are learning PBL better than conventional learning. If the note characteristics of learning from them is a thing that is natural occurrence of difference. Theoretically PBL has several advantages when compared to direct learning model in excellence-excellence is maximized in the implementation in the classroom allows the learning process for the better. In line with it (Wihatma, 2004; Noor, 2005; Hasanah, 2005; Suparlan, 2005; Astrid, 2010; Sugandi, 2010; Abdullah, et al, 2010; Siti, 2013; Oktaviani, 2015; Sufi, 2016) suggests that PBL is an efficient strategy can improve the performance of math on student teamwork, problem-solving skills and mathematical communication skills of students. Other relevant research results from different countries (Cazola, 2008; Belgin, et al, 2009; Chen, 2013; Karami, et al. 2013; Ku, 2016) .

It can also be seen in terms of learning materials developed and packaged in the form of cerealcontectual problems which include the LAS. With LAS, students are encouraged through active creative act find answers

based on the process of PBL to the problem, circumstances or situations that are faced and draw conclusions through the scientific thinking processes are critical, logical, and systematic. In PBL students are also required to train and develop their own communication skills and independence of their learning. Whereas in conventional learning, learning materials used is a commonly used textbook by teachers and learning activities conducted by discussing examples of reserved and continued with the exercise. It thus makes learning PBL better in learning mathematics.

Not only that, on the PBL teacher serves as a facilitator and motivator who set the students learn and provide direction in order for the material to be learned are understood and meant students through teacher intervention in form therefore refers to the group. Forms of intervention the teacher upon the student teacher is done cooperating indirectly, i.e. by using the techniques of scaffolding. On the techniques of scaffolding teacher required skillful use questions that can help students, among others, which is very important is to solve complex questions for students into questions that are more affordable simple minds of students at that time. The questions asked the teacher in the form of questions. In the meantime, direct learning, the teacher acts as a learning resource, explains the concept, explain the problem, give examples of problems to do exercise students in accordance with the example given. The role of the teacher in the learning process above resulted in the occurrence of memorization of the concept or procedure. This has resulted in conventional learning interactions take place in only one direction. Unlike the case with the study of PBL that creates interaction multidirectional and can cultivate a dynamic, democratic atmosphere, and taste in learning mathematics. This led to the granting of study on PBL more meaningful than on conventional learning. The exact mathematical problem Representation is fundamental in understanding the problem and make a plan to solve them (Surya,, dkk, 2013; Choridah, 2013).

From the results of the research settlement answers that do students, learning answers on completion of the process of PBL gained assessment criteria of "good" compared with the process of the resolution of conventional learning on students ' answers. On completion of the process of learning on the students ' answers to PBL is more systematic, more structured, as well as in accordance with the mathematical communication ability indicators measured, if compared to the process of the resolution of conventional learning on students ' answers. This is because during the process of PBL learning interaction between students with teachers often occurs, which in the end will make the students brainstorm and be able to reflect the understanding that had he had before.

Based on the results of researchoverall for all indicatorsindependence studystudents with learningLBCbetter thanconventional learning. This is reinforced by the findings of Suhery (2013:124) stating that the difference increased self-reliance student learning on a problem-based learning is better than conventional learning. Furthermore the theory of Vygotsky (Arends, 2008b: 47) believed that intellectual property developed when they attempted to resolve the problem posed by these experiences. In this experience, the individual connecting prior knowledge with new knowledge and reconstruct a new meaning. According to Vygotsky, the student has two different development level, i.e. the level of development of the actual and potential level of development. The actual level of development determines the function of the individual's current intellectual and his ability to learn certain things myself. The individual also has a level of development potential by Vygotsky (Trianto, 2011:39) is defined as the level which can be enabled or accomplished individuals with the help of others, such as teachers, parents, or the more advanced peers. The zone is located between the level of development of actual and potential level of development of the student is referred to as the zone of proximal development. The next theory Brunner (Arends, 2008b: 48) described a scoffolding as the process of the students who helped to resolve certain problems that are beyond the capacity of its development with the help of a teacher or someone more capable. So it can be inferred , there is significant influence model (PBL, conventional) against the independence of the study.

This is because during the process of PBL learning interaction between students with teachers often occurs, which in the end will make the students brainstorm and be able to reflect the understanding that had he had before. This is in line with the theories of Piaget (Trianto, 2011:29) which States that "social interaction with peers, especially the argument and discussion helped clarify thinking that ultimately contains thought-provoking it into logical". So these things have an impact on the results of the *postest* mathematical communication ability, where most students answer a systematic, structured, and in accordance with the indicators of the ability of mathematical communication.

6. Conclusion

Based on the analysis and discussion of the data from the results of research that has been done can be expressed as the following conclusion: there is a significant influence of model learning (PBL, conventional) of mathematical communication ability. There is a significant influence of model learning (PBL, conventional) against the independence of student learning. Checkout process answers the student in resolving mathematical communication skills on learning PBL better, systematic and structured than the conventional learning. Of these three indicators are measured based on the findings of the field to see that the mathematical expression of the

indicator is still considered difficult by students.

References

Abdullah, N. I., Tarmizi, R.A., Abu, R. (2010). The Effects of Problem Based Learning on Mathematics Performance and Affective Attributes in Learning Statistics at Form Four Secondary Level. *International Conference on Mathematics Education Research (ICMER 2010)*, pp. 370-376.

Ansari, B.I. 2012. *Komunikasi Matematik dan Politik Suatu Perbandingan Konep dan Aplikasi.* Banda Aceh: Yayasan PeNa.

Astrid, A. (2010*). Hubungan Antara Self Efficacy dengan Kecemasan Berbicara di Depan Umum pada Mahasiswa Fakultas Psikologi Universitas Sumatera Utara*. Medan ; USU.

Baroody, A. J. 1993. *Problem Solving, Reasoning, and Communicating, K-8: Helpingchildren think mathematically*. New York: Macmillan Publishing Company.

Barrows, H. S. and Tamblyn, R. M. (1980). *Problem-Based Learning: An Approach to Medical Education.* New York: Springer.

Barrows, H. S. (2000). *Problem-Based Learning Applied to Medical Education.* Springfield, IL: Southern Illinois University School of Medicine

Belgin, I., Senocak, E., dan Sozbilir, M. (2009). The Effects of Problem-Based Learning Instruction on University Students' Performance of Conceoptual and Quantitative Problems in Gas Concepts. *Eurasia Journal of Mathematics Science Technology Education.* Vol. 5 No. 2, pp 153-164.

Cazola, M. (2008). Problem-Based Learning and Mathematics : Possible Synergical Actions. *ICERI2008 Proceeding*, *IATED (International Association of Technology, Education and Development),* Valencia, Spain, 2008 (ISBN: 978-84-612-5091-2)

Chen, W. H. (2013). Applying Problem-Based learning Model and Creative Design to Conic-Sections Teaching. *International Journal of Education and Information Technologies.* Issue 3, Volume 7, pp.73-80.

Cheong, F. (2008). Using a Problem-Based Learning Approach to Teach an Intelligent Systems Course. *Journal of Information Technology Education* Volume 7, pp. 47-60.

Choridah, D. T. (2013). Peran Pembelajaran Berbasis Masalah Untuk Meningkatkan Kemampuan Komunikasi dan Berpikir Kreatif serta Disposisi Matematis Siswa SMA. *Infinity Jurnal Ilmiah Program Studi Matematika STKIP Siliwangi Bandung,* Vol 2, No.2, September 2013, pp.194-202.

Darr, C., & Fisher, J. (2004). *Self-Regulated Learning in Mathematics Class*. Tersedia : www.arb.nzcer.org.n-z

Dochy, F., Segers, M., van den Bossche, P., and Gijbels, D. (2003). Effects of problem-based learning: a meta-analysis. *Learn. Instruct*., 13, 533–568.

English, M. C. and Kitsantas, A. (2013). Supporting Student Self-Regulated Learning in Problem- and Project-Based Learning. *Interdisciplinary Journal of Problem-Based Learning.* Volume 7, Number 2 Article 6

Fauzi, A. 2011. *Peningkatan Kemampuan Koneksi Matematis dan Kemandirian Belajar Siswa dengan Pendekatan Pembelajaran Metakognitif di Sekolah Menengah Pertama*. Makalah disajikan dalam Seminar Internasional dan Konferensi Nasional ke-4, Jurusan Pendidikan Matematis UNY Yogyakarta, 21-23 Juli.

Fatade, A. O., Mogari, D., Arigbabu, A. A. (2013*)* Effect of Problem-Based Learning on Senior Secondary School Students' Achievements in Further Mathematics. *Acta Didactica Napocensia.* Volume 6, Number 3, pp. 27-44.

Gallagher, S. A., Stepien, W. J., and Rosenthal, H. (1992). The effects of problem-based learning on problem solving. *Gifted Child Q*., 36(4), 195–200

Hasanah, A. (2006). Mengembangkan Kemampuan Pemahaman dan Penalaran Matematika Siswa Sekolah Menengah Pertama Melalui Pembelajaran Berbasis Masalah yang Menekankan pada Representasi Matematik.*Tesis*. UPI Bandung. Tidak Diterbiitkan.

Hmelo-Silver, C. E. (2004). Problem-based learning: what andhow do students learn? *Educ. Psychol. Rev.,* 16(3), 235–266.

Hmelo, C. E., Holton, D. L., and Kolodner, J. L. (2000). Designing to learning about complex systems. *J. Learn.* Sci., 9, 247–298.

Karami, M., Madani, S., and Attaran, M. (2013). Integrating Problem-Based Learning With ICT for Developing Trainee Teachers' Content Knowledge and Teaching Skill. *International Journal of Education and Development using Information and Communication Technology*(IJEDICT), 2013, Vol. 9, Issue 1, pp. 36-49.

Ku, T. K. And Ha, M. (2016). The Application of Problem BasedLearning in Undergraduate NursingEducation: A Strategy for CurriculumReform. *Journal of Biosciences and Medicines,* 2016, 4, 52-59

Lilik, S., Wardatul, D., & Wagimin. 2013. Tingkat Penguasaan Self-regulated Learning Skill ditinjau dari Segi Prestasi Belajar dan Lama Studi pada Mahasiswa FKIP UNS. *Jurnal Conselium*, (Online), Vol. 1 No. 1 (http://jurnal.fkip.uns.ac.id/index.php/counsilium/article/download/706/40, 8 diakses 10 September 2015).

Marzuki. 2012. Perbedaan Kemampuan Pemecahan Masalah dan Komunikasi Matematik antara Siswa yang diberi Pembelajaran Berbasis Masalah dengan Pembelajaran Langsung. *Tesis* tidak diterbitkan. Medan:

Program Pascasarjana UNIMED.

Nasution, H. A. Syahputra, E. Siagian, P. (2013). Perbedaan Peningkatan Kemampuan Pemecahan Masalah dan Komunikasi Matematik Siswa Pada Pembelajaran Berbasis Masalah dan Pembelajaran Langsung pada Siswa Sekolah Menengah Pertama.*Jurnal Pendidikan Matematika PARADIKMA*, Vol 6 No. 1, pp.65-75.

NCTM. 2000. *Curiculum and Evaluation Standards for School Mathematics*. Reston, Virginia: NCTM.

Noor, F. S. (2005). Pengaruh Pembelajaran Kooperatif STAD terhadap Kemampuan Siswa dalam Mengerjakan Bukti dalam Matematika pada Siswa SMU. Bandung : *Tesis*SPs UPI. Tidak Diterbitkan.

Oktaviarini, A. (2015). Penerapan Model Pembelajaran Berbasis Masalah Untuk Meningkatkan Kemampuan Komunikasi Matematis.. *Prosiding Seminar Nasional Matematika dan Pendidikan Matematika*, UNY Yogyakarta 2015. ISBN : 978-602-73403-0-5, pp. 77-82.

Pape, S. (2003). Developing Mathematical Thinking and Self-Regulated Learning: Teaching Expriment in a Seventh-Grade Mathematics Classroom.*Journal of Education Psychology* 90, 682-697.

Permana, Y & Sumarmo, U. 2007. Mengembangkan Kemampuan Penalaran dan Koneksi Matematika Siswa SMA melalui Pembelajaran Berbasis Masalah. *Jurnal Educationist*, *1 (2):116-123*. (Online), (http://file.upi.edu/Direktori/JURNAL/EDUCATIONIST/Vol.1 no. 2-Juli_2007/6_Yanto_Permana_Layout2rev.pdf, diakses 13 Oktober 2015).

Portela, J. (2007). Communicating mathematics through the internet: A case study *Interactive Educational Multimedia*, Number 14 (April 2007), pp. 65-78http://www.ub.edu/multimedia/iem

Pugalee, K. D. 2001. *Using Communication to Develop Students Mathematical Literacy.Mathematics Teaching in The Middle School.* Vol. 6 No. 5: 296-299.

Qohar, A. dan Sumarmo, U. (2013). Improving Mathematical Communication Ability and Self Regulation Learning of Yunior High Students by Using Reciprocal Teaching. *IndoMS. J.M.E*Vol. 4 No. 1 January 2013, pp. 59-74

Ramellan, P., Musdi, E. dan Armiati. (2012). Kemampuan Komunikasi dan Pembelajaran Interaktif. *Jurnal Pendidikan Matematika*, UNP Padang. Vol. 1 No. 1, Part 2 pp. 77-82.

Santoso, F.G.I. 2015. Pengaruh Gender Terhadap Motivasi Berprestasi Siswa SMP Kelas VIII dalam Pembelajaran Berdasarkan Masalah. *Jurnal Widya Warta,* (Online) No. 2 ISSN 0854-1981. (http://portal.widyamandala.ac.id/jurnal/index.php/warta/article/download/305/293, diakses 10 November 2015).

Saragih, S. 2007. Mengembangkan Berpikir Logis dan Komunikasi Matematika Siswa Sekolah Menengah Pertama melalui Pendekatan Matematika Realistik. *Disertasi* tidak diterbitkan. Bandung: UPI.

Schmidt, H. G. (1983). Problem-based learning: rationale and description. *Med. Educ*., 17, 11–16.

Siregar, N. F. (2016). Pemahaman dan Komunikasi Matematis Dalam Pembelajaran Matematika Realistik. *Logaritma,* Vol. IV, No. 01 Januari 2016, pp. 17-36.

Siti, F. (2013). Pengaruh Model Pembelajaran Kooperatif Tipe Stad Dan Self Efficacy Siswa Terhadap Kemampuan Komunikasi Matematika Siswa SMP. Masters *Thesis*, Universitas Terbuka.

Stahl, G., Cakir, M. P., Weimar, S., Kofi, B. Wewsijana, Qu, J. X. (2010). Enhancing Mathematical Communication for Virtual Math Teams. *Acta Didactica Napocensia*. Vol. 3 Number 3, pp. 101-114.

Sufi, L. F. (2016). Meningkatkan Kemampuan Komunikasi Matematis Siswa Melalui Model Pembelajaran Problem Based Learning. *Prosiding Konferensi Nasional Penelitian Matematika dan Pembelajarannya, UMS Surakarta*, pp. 37-42. ISSN : 2502-6526.

Sugandi,A.I (2010). *Pengaruh Pembelajaran Berbasis Masalah dengan Setting Kooperatif Tipe Jigsaw terhadap Pencapaian Kemampuan Berpikir Matematis Tingkat Tinggi dan Kemandirian Belajar Siswa SMA di Kodya Bandung*. Laporan Penelitian IKIP Bandung: Tidak diterbitkan.

Sugiyono. 2010. *Metode Penelitian Kuantitatif Kualitatif dan R&D*. Bandung: Alfabeta.

Sungur, S., and Tekkaya, C. (2006). Effects of Problem-Based Learning and Traditional Instruction on Self-Regulated Learning. *The Journal of Educational Research.* May/June 2006 [Vol. 99 (No. 5)] pp. 307-317.

Suhery, D., Saragih, S., & Syahputra, E. 2013. Peningkatan Kemampuan Pemecahan Masalah Matematik dan Kemandirian Belajar Siswa SMA di Kabupaten Aceh Tenggara melalui Pembelajaran Berbasis Masalah. *Jurnal Mathematics Pedagogik*, (Online), Vol. III, No. 2, Maret 2013, (http://digilib.unimed.ac.id/public/UNIMED-Article-30542-Peningkatan%20Kemampuan%20Pemecahan%20Masalah.pdf, diakses 20 Oktober 2015).

Suparlan, A. (2006). Pengembangan Berbasis Masalah untuk Mengembangkan Kemampuan Pemahaman dan Representasi Matematis Siswa Sekolah Menengah Pertama. *Tesis* pada SPs UPI Bandung. Tidak Diterbitkan.

Surya, E. dan Riska Rahayu. (2014). Peningkatan Kemampuan Komunikasi dan Pemecahan masalah Matematis Siswa SMP Ar-Rahman Percut Melalui Pembelajaran Kooperatif Tipe Student Teams Achievement Division. *Jurnal Pendidikan Matematika PARADIKMA,* Vol. 7 Nomor 1, hal. 24-34.

Surya, E., Jozua Sabandar, Yaya S. Kusumah, Darhim (2013).Improving of Junior High School Visual Thinking

Representation Ability inMathematical Problem Solving by CTL.*JME Journal on Mathematics Education, IndoMS.*Vol. 4 No. 1 January 2013, p. 113-126, http://jims-b.org/?p=513

Trianto. 2011. *Mendesain Model Pembelajaran Inovatif-Progresif: Konsep Landasan dan Implementasi Pada Kurikulum Tingkat Satuan Pendidikan* (KTSP). Jakarta: Kencana Prenada Media Group.

Torp, L. and Sage, S. (2002). *Problems as Possibilities: Problem-Based Learning for K–12 Education*, 2nd ed. Alexandria, VA: Association for Supervision and Curriculum Development.

Wihatma, U. (2004). Meningkatkan Kemampuan Komunikasi Matematik Siswa SLTP melalui Cooperative Learning Tipe Student Teams-Achievement Division (STAD*),* Bandung: *Tesis* SPs UPI. Tidak diterbitkan

Wijaya, H. P. I., Imam Sujadi, I., Riyadi. (2016). Kemampuan Komunikasi Matematis Siswa SesuaiDengan Gender Dalam Pemecahan MasalahPada Materi Balok Dan Kubus (Studi Kasus Pada Siswa SMP Kelas VII SMP Islam. *Jurnal Elektronik Pembelajaran Matematika.* UNS, ISSN: 2339-1685 Vol.4, No.9, hal 778-788.

Williams, S. M. and Hmelo, C. E. (1998). *Guest editors' introduction.* J. Learn. Sci., 7(3/4), 265–270.

Zimmerman, B. J., & Schunk, D. H. (1989). *Self-regulated Learning and Academic Achievement:Theory, Research, and Practice*. New York: Springer- Verlag.

Zumbrunn, S., dkk. 2011. *Encouraging Self-Regulated Learning in the Clasroom: A Review of the Literature*. Virginia Commonwealth University